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The use of the compact NCCU electron gun to generate radiation from the microwave region to above one Terahertz has been demonstrated. Several radiation mechanisms were explored, including waveguide excitation, transition radiation, and a grating-coupled device.

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Novel Sources for the Far-Infrared Utilizing a 1 MeV Electron Gun

FINAL REPORT

Submitted by: Professor Charles R. Jones

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U. S. ARMY RESEARCH OFFICE

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Final Report

Over the course of this project the NCCU electron gun was successfully completed and used to conduct a variety of experiments on the generation of radiation in the far-infrared. The first "proof-of -principle" experiments studied the radiation produced when a rectangular waveguide was excited by passing the electron beam transversely across the waveguide. These results have been reported in a paper submitted to Applied Physics Letters.

Observation of strong transition radiation while performing the waveguide experiments led us to look more closely at transition radiation as a tool for generating radiation. Two experiments were conducted and much was learned regarding the adjustment of gun parameters to optimize the electron bunch shape and maximize the radiation generated. The power generated and the spectral coverage obtained has steadily increased. Although accurate power estimates are difficult to obtain, considerably more power was obtained with the transition radiation mechanism than with the initial waveguide experiments. The average power on each harmonic, during the macropulse, is estimated to be greater than a milliwatt over the range from 100 to 1000 GHz. The micropulse length in the time domain is less than a picosecond so this corresponds to a peak power in the micropulse of at least several hundred Watts. Some power is observed up to 4 THz but accurate studies above 1 THz will require improving and purging the spectrometer. A paper is in preparation on the transition radiation experiments to date.

In addition to the waveguide and transition radiation studies, some time was devoted to studying the operation of an orotron device fabricated by researchers from Ohio State University. We found that the device would oscillate on individual harmonics between about 270 and 300 GHz and could be adjusted to operate simultaneously on as many as a two dozen harmonics. Power levels again were estimated to be on the order of milliwatts per harmonic. Further experiments on grating-coupled devices are planned in collaboration with researchers at Duke University, Dartmouth College, and Ohio State University.

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